

AWASUKA CONFINED BLOCK MANUAL



FOR EARTHQUAKE-RESISTANT NEW HOUSES

Autumn 2017

BHIMPHEDI AWASUKA भीमफेदी आवासुका कि 🍙 🌐 🚞 🎯



CONFINED MASONRY DEFINITION

DEFINITION

MEANING OF 'CONFINED'

The meaning of **confined** is similar to **wraped** or **tied**, so Confined Masonry means building in a way that all the small masonry elements will be wrapped or tied together, so that they do not move separately when an earthquake happens.

AN EARTHQUAKE RESISTANT TECHNIQUE THAT CONFINES ALL THE SMALL ELEMENTS TOGETHER

 - CONFINING ELEMENTS are the reinforced concrete elements that tie the whole construction together. There are two types of these Confining Elements: Horizontal Elements or Concrete Beams, with different names depending on their location: plinth beam, sill beam, lintel beam, ring beam, roof beam)
Vertical Elements or Concrete Pillars, also called Concrete Columns.

- **CONFINED ELEMENTS** are the small masonry elements, which can consist on different materials like: **brick**, **block**, **stone**... All these small elements inside the confining elements are called: Masonry Infill.

CONFINED BRICK

ring beam CONCRETE BEAM Brick Infill 1 CONCRETE BEAM CONCRETE BEAM masonry infill CONCRETE BEAM **CONFINE or TIE** Ы CONCRETE Block Block \mathbf{z} Infill Infil ONCRETE BEAM ONCR plinth beam

AND AVAC

CONFINED BLOCK

CONFINED MASONRY DEFINITION MAIN FEATURES

STRUCTURAL RULES

a) The Confining Pillars are placed along the wall to tie it properly, every 3 meters maximum.

- **b)** The structural behaviour is not like a pillar structure, it's a **load bearing wall** structural system, using "confined walls" or "tied walls".
- c) The Pillars have same thickness as the block walls.
- d) The Vertical steel rods: every 1 meter
- e) The Horizontal steel rods: every 3 block rows





Vertical Rods must always be well-tied to Horizontal rods, just like when hugging a tree









CONFINED MASONRY DEFINITION CONSTRUCTION STEPS







CONFINED MASONRY DEFINITION SOCIAL AWARENESS MATERIAL

SONG & VIDEO

Block, Wood or Stone is a song that was composed to raise awareness about **safe houses** in an entertaining and playful way. The song video was produced with Bhimpehdi Guys, a very popular dance group in Nepal. Thanks to this, the video has reached many persons and the safe-houses message has been spread all over the country. This is the video name in Youtube:

BLOCK, WOOD or STONE | Monica Sans Duran ft. Bhimphedi Guys | Social Awareness Video | AWASUKA

Bhimphedi-Awasuka **Confined Block** Prototype can be seen from 2:30 to 04:42, along with a playful explanation about how it works. Later on, the song starts from 8:37 until the end.

SIGNBOARD

For a better dissemination about safe houses' information, as well as earthquake-resistant features, three posters were designed to be hung in each of the three Bhimphedi prototypes. Each poster shows a visual explanation of how it was built and how it works. Here's the confined block one:

1. Lack of Plinth Beam under walls 1. Plinth Beam connected to walls and pillars





The **short-movie** before the song teaches simple earthquake-resistant techniques - some of which have existed in Nepal for centuries. It focuses on the techniques Awasuka has used in the three Prototypes in Bhimphedi: Confined Block, Wood (Kat) and Stone-Mud (Dhunga-Mato). It features a school teacher explaining to her young students some playful lessons about these three prototypes and the reasons why they are earthquake-resistant.



This short-movie's snapshot shows the moment when the teacher is explaining how the Confined Block technique works in case of an earthquake. Some children are asked to be blocks and another one is asked to be the earthquake. The fun part comes when they have to interact with each other.



CONFINED MASONRY PARTS

DIFERENT PARTS





CONFINED MASONRY PARTS

1. FOUNDATIONS

SITE FIXING

- First step is site fixing: we will need to measure 3 dimensions in the shape of a triangle, to ensure it is a right angle.



TRENCH EXCAVATION

-Second step is trench excavation for the strip foundations, in which we will place: first the lean concrete, second the stone masonry with mud and third, we will start preparing the plinth beam.







CONFINED MASONRY PARTS

2. PLINTH BEAM

ROD PLACING

Third step is the rod display in the beam:

- The connection between rods has to be done properly, always respecting the **overlapping** length.

- The minimum overlapping length must be **60 times the rod's diameter**. *Example: rod diameter 10mm=> overlap 60 cm.*

- Make sure the **vertical rods (projections)** are placed correctly, according to the blocks' modules and to the doors and windows.

Plinth beam dimensions: 20 x 20 cm







CONFINED MASONRY PARTS

2. PLINTH BEAM

CONCRETING

Fourth step is the concreting:

- The concreting has to be done with some formwork.
- Concrete mix must follow the **proportion** guidelines given in this Manual, above all: no exceeding water should be added.
- The upper **surface** should always look **rough**, not smooth, that's why the water proportion must be respected.





The plinth's beam surface after concreting must be **rough**, not smooth





CONFINED MASONRY PARTS

3. WALLS

BLOCKS

Awasuka Blocks have been made following the Government (NRA) guidelines and they have a **higher compressive strength** than the local ones. They have been tested and certified in Pathlaiya Materials Laboratory. These are the differences between the two:

LOCAL BLOCK

PROPORTION = 1:7:9 (CEMENT: SAND: AGGREGATE) * MINIMUM COMPRESSIVE STRENGTH = **5Mpa** (NRA) COMPRESSIVE STRENGTH = **1,77Mpa** (Lab Results March 8 2018) WEIGHT = 15kgs

=> NOT ALLOWED

AWASUKA BLOCK

PROPORTION = 1:1,5:3 (CEMENT: SAND: AGGREGATE) * MINIMUM COMPRESSIVE STRENGTH = **5Mpa** (NRA) COMPRESSIVE STRENGTH = **7,05Mpa** (Lab Results March 8 2018) WEIGHT = 18kgs

=> ALLOWED



Awasuka architects supervising block manufacture in Hetauda block factory. Resulting blocks have a darker grey color due to higher cement proportion. Upper left: block positioning before mortar.



BLOCK DIMENSIONS { LOCAL BLOCK = AWASUKA BLOCK } 40cm x 15cm x 20cm 15,75" x 5,91" x 7,87"

PERFECT POSITIONING OF BLOCKS

- Place the <u>first row</u> of blocks **without mortar** to make sure the iron rods fit in the block's holes

- All corners have to be "empty" (no blocks)
- Do not forget to leave an opening without blocks, for the door opening!!!
- Mark the location of each block on the ground, then take them out.
- Start placing the blocks again, this time using mortar.







CONFINED MASONRY PARTS



3. WALLS

BONDING RULES

a) Arrange blocks in courses so that the **vertical** joints of the different courses do not lie in same vertical line. Bonding spreads loads across wall.

b) Level the wall vertically and horizontally

c) For vertical reinforcements, be sure to make a **big hole** in the blocks, big enough to pour the concrete inside it.





CONFINED MASONRY PARTS



3. WALLS

CONCRETE MIX PROPORTIONS

CONCRETE for PLINTH BEAM: 1 cement + 3 sand + 3 gravel + water



CONFINED MASONRY PARTS

3. WALLS

VERTICAL & HORIZONTAL REINFORCEMENTS

VERTICAL RODS (VR)

-Must be placed @ EQUAL DISTANCES between pillars, maximum distance: 1m.

HORIZONTAL RODS (HR)

- Must be placed @ 2-3 ROWS of blocks, maximum distance without a rod: 3 rows.





CONFINING PLINTH BEAM





CONFINED MASONRY PARTS

3. WALLS

VERTICAL REINFORCEMENTS

- A vertical reinforcement will be placed every **1 meter**.
- This reinforcement will be **connected** to the plinth beam.
- To make the execution possible, the vertical reinforcement will be done **by different overlapped rods,** always respecting the appropriate overlapping length (**O**).
- All the block holes containing vertical reinforcements have to be **filled with concrete**.











CONFINED MASONRY PARTS

3. WALLS

HORIZONTAL REINFORCEMENTS

-Every **2-3 rows,** a "surrounding rod" will be placed around the whole perimeter.

-The minimum overlapping length for the "surrounding rod" will be **60 times the rod's diameter**. *For example: rod diameter 10mm: 60 cm overlap.*

-The mentioned "surrounding rod" has to be tied to the vertical rods.

- The *"surrounding rod"* coincides with the mortar joints, that's why a small hole will be done on the blocks side, so that the block will absorve the rod's thickness. *(As shown in next page)*











CONFINED MASONRY PARTS

3. WALLS

HORIZONTAL REINFORCEMENTS

- The **rods** for horizontal reinforcements will be placed inside the blocks. To be able to do this without affecting the joint's thickness, the upper part of the blocks will be cut away to let the rod pass through:



At Sill beam level, blocks are upside down. In rest of horizontal reinforcements, blocks are in normal position





CONFINED MASONRY PARTS

3. WALLS







a) Windows and Doors must be placed according to the blocks **modulation**.

b) All openings must always be **surrounded by vertical reinforcements.**

c) Wall corners finishings will be completed with **half block** pieces.

d) At the windows, horizontal reinforcements will be interrupted: these rods will be **tied to the vertical reinforcements** at doors and windows.

e) Windows and doors will be anchored to the wall with **hole pass** made by a bended rod nailed
to the wooden frame.









CONFINED MASONRY PARTS

4. PILLARS

- The pillars' rods must be **fixed** to the 4 projections at the plinth beam.
- The pillar rods must be tied with stirrups every 10 cms.
- Ensure the concrete covers all structural elements (beams and pillars) at least 2 - 2,5cms.









CONFINED MASONRY PARTS

4. PILLARS

Pillars are **concreted** all **at once**, after the walls are finished. And concrete for pillars must have **small aggregate** (chickpea size)



Pillars' formwork: outside and inside only



Pillar concreting is finished and the formwork has been removed

CONFINED MASONRY PARTS





CONFINED MASONRY PARTS

5. LINTEL BEAM

- a) Tie the horizontal rods with the stirrups.
- **b)** When making the stirrups: **do not bend them too much**, otherwise it'll be difficult to set them in place later! (See YES and NO example below)

c) At one of the four walls of the building, the roof beam and the lintel beam will coincide. In that case, we need to connect the two lower rods of the roof beam with the rest of the two rods of the lintel beam, at the other three walls of the building.

a) Tying the horizontal rods with the stirrups



c) Placing the roof beam at one of the four walls of the building



YES

NO





CONFINED MASONRY PARTS

6. ROOF BEAM

- Connections between rods have to be done properly, with the necessary **overlap**.

- The minimum overlapping length must be **60 times the rod diameter**. *Example: rod diameter 10mm => 60 cm overlap*

- The horizontal rods must be **connected** to the pillar rods and vertical reinforcements.







CONFINED MASONRY PARTS

6. ROOF BEAM

ROD PLACEMENT

Once the concrete has been poured in the lintel beam, there will be several **projections (rods)** peeping out of the concrete:

Roof Beam Projections (Rods)
Pillar Rods
Vertical Reinforcement Rods

ROD PLACEMENT

a) Once the first roof beam portion is done, we must build the wall at the opposite side, in order to form the proper roof inclination.

b) When the wall is finished, the **roof beam rods** will be placed on top of the wall, all will be **connected** to the projections (rods).

c) After fixing the rods, the roof beam formwork will be placed, and the rest of the concrete will be poured, in separate stages.

NOTE: the triangular wall and the inclined roof beam can also be done at once and not in different stages, depending on the mason's skills.



Different types of rods seen in this picture: 1-Roof Beam rods, 2-Pillar rods, 3- Vertical Rods











CONFINED MASONRY PARTS

2. ROOF STRUCTURE

OPTION 1: ONE-SLOPE ROOF

The confined block prototype can be ended in two different ways, depending on the type of growth the owner needs. This one has a **one-slope roof**, so it can grow symetrically from the longest side and the **porch** can also be easily built in the **long side**. The porch can also be built in the short side, but it will need some extra anchoring points.





CONFINED MASONRY PARTS

2. ROOF STRUCTURE

OPTION 2: TWO-SLOPE ROOF

The confined block prototype can be ended in two different ways, depending on the type of growth the owner needs. This one has a two-slope roof, so it can be extended equally from the longest side and the **porch** can be easily built in the two **short sides**. The porch can also be built in the long side, but it will need some extra anchoring points.



